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DAYTON
AIR POLLUTANT EMISSION
INVENTORY

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
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The report is a compilation of air pollutant emissions in the Dayton (Ohio) Metropolitan Area. The objectives of this emission inventory were to determine the quantity of the various air pollutants emitted as well as delineate their geographical and seasonal variations. This was done by using a modified form of the Rapid Survey Technique. The study area was divided into a grid coordinate system, and the emission quantities were reported in terms of tons of pollutants per grid for a summer, winter, and average day. The pollutants considered in this survey were sulfur oxides, particulates, carbon monoxide, hydrocarbons, and oxides of nitrogen.

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U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
Consumer Protection and Environmental Health Service
National Air Pollution Control Administration
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INTRODUCTION

This report is a compilation of air pollutant emissions in the Dayton metropolitan area. The objectives of this emission inventory were to determine the quantity of the various air pollutants emitted as well as delineate their geographical and seasonal variations. This was done by using a modified form of the Rapid Survey Technique.[1] The Study Area was divided into a grid coordinate system, and the emission quantities were reported in terms of tons of pollutant per grid for a summer, winter, and average day.

The pollutants considered in this survey were sulfur oxides, particulates, carbon monoxide, hydrocarbons, and oxides of nitrogen. Data presented herein were gathered mainly by the acknowledged agencies and are primarily representative of 1967 unless otherwise noted.

Midwest Research Institute of Kansas City was contacted by the Montgomery County Health Department to provide them with an emission inventory of the five county study area. Thus all of Midwest Research's available data were utilized for this report. However, in some areas where data were lacking, it was necessary to use information from other sources.

STUDY AREA

The Study Area, presented in Figure 1, consists of the City of Dayton which is in Montgomery county and the surrounding counties; namely, Greene, Darke, Preble, and Miami. The area occupies 2,313 square miles and contains an estimated 1967 population of 884,340 which is a 14.5 percent increase over the 1960 population (See Table 1).

Topography

The Dayton Metropolitan Area is located near the center of the Miami River Valley which is nearly a flat plain, generally 50-200 feet below the elevation of the adjacent countryside. Three Miami River tributaries - the Mad River, the Stillwater River, and the Wolf Creek - converge from the North to join the main stream within the city of Dayton.

Figure 1. Dayton study area.

TABLE 1 POPULATION AND AREA CHARACTERISTICS FOR THE DAYTON STUDY AREA, 1967

County	1960 Population	1967 Population	Land Area (Square miles)	1967 Population Density
Darke	45,610	48,210	605	79.7
Greene	94,640	118,670	415	286.0
Miami	72,900	81,300	407	199.8
Montgomery	527,080	600,140	459	1,307.5
Preble	32,500	36,020	427	84.4
Total	772,730	884,340	2,313	382.3

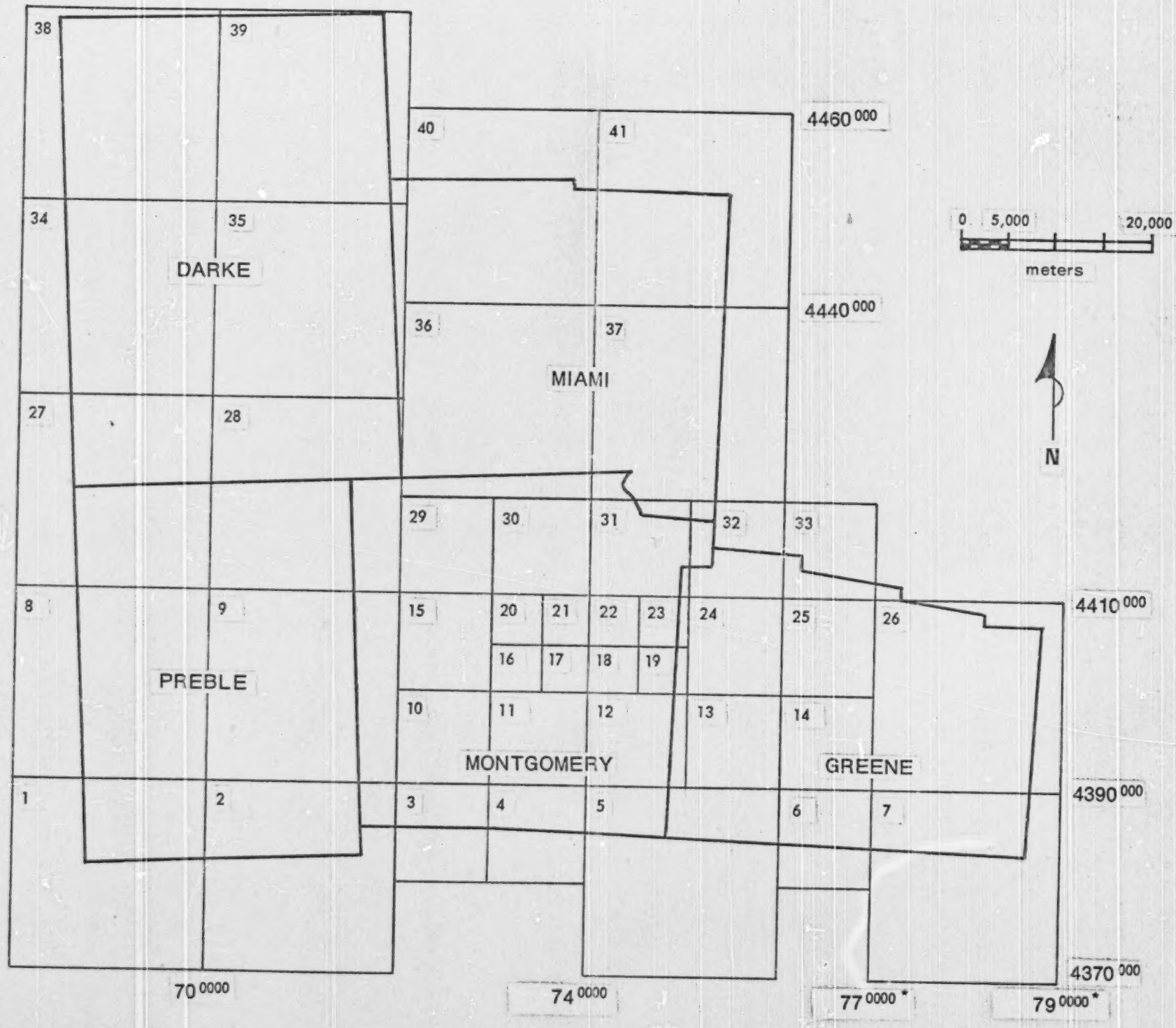

Figure 2. Dayton study area grid coordinate map.

The city of Dayton is about 750 feet above sea level. The Terrain north of the city slopes gradually upward to about 1,100 feet while south of the city the terrain slopes downward to about 450 feet where the Miami River empties into the Ohio River.

Climatology

Precipitation is rather evenly distributed throughout the year and temperatures are usually moderate. Temperatures of zero or below will occur four out of every five years whereas temperatures of 100 degrees or more will occur only once in every five years. In addition, extremes in temperature are usually of short duration.

Cold, polar air flowing across the Great Lakes, causes much cloudiness in the winter and is accompanied by frequent snow flurries. These flurries add little to the total snowfall. The wind is predominately out of the south - southwest except in February and March when west - northwest winds prevail. The wind speed averages about 8 miles per hour in the summer and about 12 miles per hour in the winter.

GRID COORDINATE SYSTEM

For the purpose of this survey, the Study Area was divided into 41 grids based on a Universal Transverse Mercator Projection (UTM). Three grid sizes of 20,000 meters, 10,000 meters, and 5,000 meters were utilized for delineating emissions of the sulfur oxides, particulates, carbon monoxide, hydrocarbons, and nitrogen oxides (Figure 2).

Since the Dayton Study Area is in two different UTM zones a problem arises in covering the area with a single system. Thus, for the purposes of this report, one zone was utilized and extended eastward. Coordinates of the extended portion of the zone are denoted by an asterisk on the map in Figure 2.

SUMMARY OF RESULTS

The following is a brief summary of pollutant emissions and

sources in the Dayton Study Area:

1. Sulfur oxides (108,000 tons per year) are emitted primarily from fuel combustion in stationary sources. The steam electric power plants contributed 57 percent almost solely from coal combustion, industry accounted for 38 percent, residential, and commercial and institutional establishments added another 4.5 percent.
2. Coal combustion accounted for more than 74 percent of the total particulate emission of almost 94,000 tons per year. Transportation sources contributed 3.5 percent; industrial processes, 16 percent; and refuse burning, 3.5 percent.
3. The major source of carbon monoxide (368,000 tons per year) was the operation of gasoline powered motor vehicles which emitted 88 percent of the total emissions. Coal combustion in stationary sources accounted for 3 percent; and industrial process, 4 percent.
4. Transportation sources account for approximately 70 percent of the 61,550 tons of hydrocarbons emitted. Fuel combustion in stationary sources accounted for 4 percent of the total while solvent evaporation amounted to 24 percent of the total.
5. Oxides of nitrogen (62,000 tons per year) were discharged primarily from coal combustion in steam electric utilities (35 percent) and in industrial plants (23 percent). Transportation sources accounted for 32 percent.

The emissions of pollutants discharged to the air in the Study Area are summarized in Table 2. The validity of these results are

TABLE 2 SUMMARY OF AIR POLLUTANTS IN THE DAYTON STUDY AREA, 1967 (TONS/YEAR)

Source	SO_x	PART	CO	HC	NO_x
Transportation	1,630	3,445	329,720	45,430	20,110
gasoline	1,180	1,560	323,300	24,700	16,900
diesel	450	1,285	700	1,580	2,580
planes	neg.	600	5,720	1,130	630
evaporation	-	-	-	18,020	-
Stationary Fuel Combustion	106,090	71,860	10,560	2,510	39,520
Industry	39,650	30,220	4,530	1,130	13,990
Steam-Electric	61,350	33,660	530	210	21,120
Residential	2,980	2,760	2,980	660	2,150
Commercial & Institutional	2,110	5,220	2,520	510	2,260
Solid Waste	80	3,205	14,410	850	1,920
Incineration	80	495	40	10	80
Open burning	neg.	2,710	14,370	840	1,840
Industrial Process	-	15,400	12,530	-	-
Solvent Evaporation	-	-	-	15,000	-
Total	107,800	93,910	367,220	63,790	61,550

neg = negligible

dependent on the accuracy and applicability of the emission factors used.[2] These factors, for the most part, represent average emission rates for a particular industry or fuel type. Because of the inherent differences in type of equipment, operating rates, control equipment, and efficiency of operation among the plants and fuel users within a given category, the application of the emission factors to any individual plant or even a smaller number of similar plants or processes may result in a discrepancy between the actual and the estimated emissions. However, the estimates of total pollutants from all sources in the study area should be fairly accurate.

EMISSIONS BY CATEGORY

For the purposes of compiling the basic data and emission estimates, the air pollutant sources were classified into the following five categories:

1. Fuel combustion in stationary sources
2. Transportation
3. Solid-waste disposal
4. Industrial process losses
5. Solvent evaporation

Fuel Combustion in Stationary Sources

All three major fuels are consumed within the Study Area with coal being the most significant. In 1967, coal accounted for 8.58×10^{13} Btu's or 58 percent of the total energy input while natural gas accounted for 34 percent and fuel oil the remaining 8 percent. Approximately 3,310,000 tons of coal, 88 million gallons of fuel and 51.1 billion cubic feet of natural gas are consumed within the Study Area (Table 3).

The seven steam-electric power plants consumed 64 percent of the total coal utilized by all sources as shown in Table 4. All of the power plants now in operation are equipped with some sort of air pollution control equipment. One plant, the Miamisburg station, was used only during peak periods in 1967 and is not in

TABLE 3 SUMMARY OF FUEL CONSUMPTION BY STATIONARY SOURCES FOR THE STUDY AREA, 1967

Source	Coal (1000's Tons)	Fuel Oil		Natural Gas (10^9 ft^3)
		Residual (10^6 gal)	Distillate (10^6 gal)	
Steam-Electric Utilities	2,110	neg.	neg.	0.1
Industry	980	20.0	8.0	12.8
Residential	120	neg.	47.0	25.0
Commercial & Institutional	100	neg.	13.0	13.2
Total	3,310	20.0	68.0	51.1

neg. = negligible

TABLE 4 SUMMARY OF FUEL CONSUMPTION IN STEAM-ELECTRIC POWER PLANTS IN THE DAYTON STUDY AREA, 1967

	Coal 1000's Tons	Natural Gas 10^6 Ft^3	Fuel Oil 1000's gal.	Controls
F. M. Tait	1,000	0	33	ESP[a]
Third Street	45	0	0	Mechanical[b]
Longworth	90	0	0	Mechanical, 1/3 fuel use has no controls
O. H. Hutchins	790	90	0	ESP, 1/4 fuel use has mechanical
Miamisburg[c]	20	0	0	None
Piqua	110	0	0	Mechanical, 1/3 fuel use has no controls
Troy	55	0	0	Mechanical, 2/3 fuel use has no controls
Total	2,110	90	33	

a. ESP - Electrostatic Precipitator

b. Mechanical - Mechanical collectors; consists of cyclone collectors or baffles, separately or in combination

c. Not in use in 1968

operation in 1968. Industry was the other large coal consumer using almost 30 percent of the total coal. The sulfur content of coal varied, ranging from 0.9 - 2.0 percent.

Fuel oil was consumed primarily in industrial operations (32 percent) and for residential home heating (54 percent), with approximately 77 percent of this fuel oil being distillate with a sulfur content ranging from 0.18 - 0.27 percent (See Table 5).

Over 49 percent of the natural gas consumed in the Study Area was used for residential purposes while 25 percent was used in industrial operations. Industrial and commercial facilities used the remaining 26 percent.

Approximately 71 percent of the total dwelling units in the Study Area used natural gas as the heating fuel. Coal was used in 7 percent, fuel oil in 20 percent and other types of fuel were used in the remaining 2 percent. This is shown in Table 6.

Fuel Apportionment and Data Sources for Stationary Sources

Residential home heating fuel use was determined by the method described on page 43 of the Rapid Survey Technique. The fuel was apportioned on a census track basis by population and totaled by grid.

Natural gas usage was obtained from the gas companies in the area and are the most accurate. They were provided on a county basis with a breakdown by industry, residential, and commercial and institutional source categories.

Residual fuel oil for the Study Area was obtained by proportioning the State fuel oil totals by manufacturing employment. All residual fuel oil was assumed to be used in industrial operations and was apportioned on a grid basis by land use maps.

Distillate fuel oil totals were obtained in the same manner as residual fuel oil. Point source information as well as residential home heating were subtracted from the total and the remainder was attributed to industrial and commercial and institutional

TABLE 5 SULFUR AND ASH CONTENT OF
FUELS CONSUMED IN THE STUDY AREA, 1967

Fuel	% Sulfur	% Ash
Coal	0.90 - 2.00	6.0 - 12.5
Residual Fuel Oil	0.90 - 1.70	-
Distillate Fuel Oil	0.18 - 0.27	-
Natural gas	0.0008	-

TABLE 6 SUMMARY OF DOMESTIC HEATING UNITS BY FUEL TYPE, 1967

County	Coal	Distillate Oil	Natural Gas	Other*
Darke	2,550	5,180	6,120	730
Greene	2,100	10,340	18,070	1,070
Miami	2,280	5,330	16,300	1,120
Montgomery	9,920	24,750	138,750	2,500
Dayton	6,020	3,640	70,520	1,880
Kettering	120	880	19,890	110
Mont. Balance	3,780	20,230	48,340	510
Preble	1,920	5,180	6,120	730
Total	18,770	50,780	185,360	6,150

* includes wood, electricity or no heat

operations. This remainder was apportioned on a grid basis with the aid of land use maps.

Coal consumption in steam-electric power plants, industrial, commercial, and institutional facilities was determined by personal contact by the aforementioned agencies.

Residential coal was found by the Rapid Survey Technique method. The remaining coal, i.e., area sources consisting of industrial, commercial, and institutional zones are estimates made by subtracting current point source data in these zones from the estimate of the total fuel consumption for the jurisdiction involved. (A point source is defined as any industry, commercial and institutional establishment, steam-electric power plant, incinerator, open dump or airport that emitted more than 0.3 tons of any of the five surveyed pollutants per day.)

A tabulation of fuel consumption by jurisdiction is shown in Table 7.

Emissions from Fuel Combustion in Stationary Sources

Air pollutant emissions resulting from fuel combustion in stationary sources are listed in Table 8 and by jurisdiction in Table 9. Although coal accounts for only 57.5 percent of the total fuel energy, it is responsible for 96 percent of the sulfur oxides, 98 percent of the particulates, 99 percent of the carbon monoxide, 95 percent of the hydrocarbons, and 80 percent of the nitrogen oxides emitted from stationary sources in the Study Area.

Fuel burning in industrial plants accounted for 37 percent of the sulfur oxides and 42 percent of the particulates while steam-electric power plants contributed 58 percent of the sulfur oxides and 47 percent of the particulates. Commercial and institutional establishments accounted for 7 percent of the particulates mainly from coal combustion.

Transportation

Two types of transportation sources of air pollution are considered

TABLE 7 SUMMARY OF FUEL CONSUMPTION BY JURISDICTION FOR STATIONARY SOURCES IN THE STUDY AREA, 1967

County	Distillate Fuel Oil 10^6 gal			Residual Fuel Oil 10^6 gal	Coal 1000's tons			Natural Gas 10^9 ft^3		
	Res	Ind	C&I		Res	Ind[a]	C&I	Res	Ind[a]	C&I
Darke	5.4	0.5	1.0	neg.	18.0	20	10	1.00	1.10	0.63
Greene	9.6	0.7	1.0	3.0	13.0	350	15	2.40	0.30	1.22
Miami	5.1	1.0	1.0	2.5	15.0	255	20	2.30	1.20	1.25
Montgomery	22.6	6.5	8.0	14.5	61.0	2,435	45	18.70	9.90	9.80
Preble	4.3	0.3	1.0	neg.	13.0	30	10	0.60	0.40	0.30
Total	47.0	9.0	12.0	20.0	120.0	3,090	100	25.00	12.90	13.20

a. includes steam-electric power plants
b. Neg = negligible
Res = residential
Ind = industrial
C&I = commercial & institutional

TABLE 8 SUMMARY OF AIR POLLUTANT EMISSIONS
FROM FUEL CONSUMPTION IN STATIONARY SOURCES
FOR THE STUDY AREA, 1967 (TONS/YEAR)

Source	SO_x	PART	CO	HC	NO_x
Industry					
Coal	36,280	29,400	4,470	1,085	9,760
Fuel oil	3,370	580	60	45	2,010
Natural gas	neg	240	neg	neg	2,220
Total	39,650	30,220	4,530	1,130	13,990
Residential					
Coal	2,230	2,340	2,930	590	470
Fuel oil	740	190	40	70	280
Natural gas	10	230	10	neg	1,400
Total	2,980	2,760	2,980	660	2,150
Commercial & Institutional					
Coal	1,920	5,000	2,500	500	400
Fuel oil	180	90	10	10	440
Natural gas	10	130	10	neg	1,420
Total	2,110	5,220	2,520	510	2,260
Steam-Electric					
Coal	61,350	33,660	530	210	21,120
Fuel oil	neg	neg	neg	neg	neg
Natural gas	neg	neg	neg	neg	neg
Total	61,350	33,660	530	210	21,120
Total					
Coal	101,780	70,400	10,430	2,385	31,750
Fuel oil	4,290	860	110	125	2,730
Natural gas	20	600	20	neg	5,040
Total	106,090	71,860	10,560	2,510	39,520

Neg = Negligible

TABLE 9 AIR POLLUTANT EMISSIONS FROM FUEL CONSUMPTION IN STATIONARY SOURCES BY JURISDICTION FOR THE STUDY AREA, 1967 (TONS/YEAR)

County	Source	SO_x	PART	CO	HC*	NO_x
Darke	Industrial	390	1,010	30	10	340
	Residential	420	380	440	100	150
	Commercial & Institutional	220	520	250	50	150
	Steam-electric	0	0	0	0	0
	Total	1,030	1,910	720	160	640
Greene	Industrial	18,050	9,950	3,450	710	3,370
	Residential	400	320	330	80	250
	Commercial & Institutional	300	770	380	80	220
	Steam-electric	0	0	0	0	0
	Total	18,750	11,040	4,160	870	3,850
Miami	Industrial	2,300	4,800	140	50	1,160
	Residential	350	330	370	80	220
	Commercial & Institutional	400	1,020	500	100	250
	Steam-electric	4,080	7,770	40	15	1,650
	Total	7,130	13,920	1,050	245	3,280
Montgomery	Industrial	18,340	28,360	13,390	340	8,770
	Residential	1,510	1,450	1,520	330	1,420
	Commercial & Institutional	980	2,400	1,140	230	1,520
	Steam-electric	57,270	25,890	490	195	19,470
	Total	78,100	58,100	16,540	1,095	31,180
Preble	Industrial	570	1,500	50	20	350
	Residential	300	280	320	70	110
	Commercial & Institutional	210	510	250	50	110
	Steam-electric	0	0	0	0	0
	Total	1,080	2,290	620	140	570

* does not include solvent evaporation

in this survey - road vehicles and aircraft. Road vehicles which are by far the more important source of air pollution in this category are further subdivided according to type of fuel - gasoline or diesel.

Emissions from road vehicles were determined from a transportation study done by the Regional Transportation Committee in 1963.[3] Vehicle mile totals were given for Montgomery and Greene counties. These totals were apportioned by grid from traffic flow maps, increased to account for secondary roads not included in the survey, and then finally updated to 1967. Gasoline consumption (See Table 10) was used to determine emissions for the remainder of the Study Area, as well as for updating vehicle mile totals for Montgomery and Greene counties.[4]

Emissions from diesel powered vehicles were found from diesel fuel consumption in the Study Area. They were apportioned on a grid basis by assuming they were proportional to gasoline use.

Aircraft

Total aircraft operations were supplied by the Federal Aviation Administration.[5] A breakdown is given by itinerant and local operations as shown in Table 11. A flight is defined as the combination of a landing and takeoff operation.

The quantities of pollutants attributed to transportation sources is summarized in Table 12. Almost 330,000 tons of carbon monoxide, more than 20,000 tons of nitrogen oxides, and over 45,000 tons of hydrocarbons which include evaporation losses were emitted in the Study Area.

Gasoline powered motor vehicles account for over 98 percent of the total carbon monoxide, 56 percent of the hydrocarbons, and 85 percent of the total nitrogen oxides in this source category.

Aircraft account for a small percentage of the total transportation emissions. However, because of their limited land area,

TABLE 10 MOTOR FUEL CONSUMPTION AND VEHICLE REGISTRATION FOR THE STUDY AREA, 1967

County	Gasoline 1000's gal	Diesel 1000's gal	Auto Registration
Darke	17,400	1,220	23,500
Greene	33,600	2,370	59,010
Miami	29,200	2,060	40,780
Montgomery	226,000	16,000	282,530
Preble	12,300	870	16,850
Total	318,500	22,520	422,670

TABLE 11 AIRPORT FLIGHTS* IN
THE DAYTON STUDY AREA, 1967

Airport	Air Carrier	General Aviation	Military
Dayton	24,600	78,700	360
Wright - Patterson AFB	0	0	25,200
Total Study Area	24,600	78,700	25,560

* A flight is defined as the combination of a takeoff and landing

TABLE 12 SUMMARY OF AIR POLLUTANT EMISSIONS FROM MOTOR VEHICLE SOURCES IN THE STUDY AREA, 1967 (TONS/YR)

County	Source	SO_x	PART	CO	HC	NO_x
Darke	gasoline	65	85	17,700	1,350	920
	diesel	25	70	40	90	140
	evaporation	-	-	-	980	-
	Total	90	155	17,740	2,320	1,060
Greene	gasoline	120	165	34,100	2,600	1,780
	diesel	45	135	70	170	270
	evaporation	-	-	-	1,900	-
	Total	165	300	34,170	4,670	2,050
Miami	gasoline	110	140	29,600	2,300	1,550
	diesel	40	120	60	140	240
	evaporation	-	-	-	1,650	-
	Total	150	260	29,660	4,090	1,790
Montgomery	gasoline	840	1,110	229,400	17,500	12,000
	diesel	320	910	500	1,120	1,830
	evaporation	-	-	-	12,800	-
	Total	1,160	2,020	229,900	31,420	3,030
Preble	gasoline	45	60	12,500	950	650
	diesel	15	50	30	60	100
	evaporation	-	-	-	690	-
	Total	60	110	12,530	1,700	750
Total Study Area	gasoline	1,180	1,560	323,300	24,700	16,900
	diesel	445	1,285	700	1,580	2,580
	evaporation	-	-	-	18,020	-
	Total	1,625	2,845	324,000	44,300	19,480

- = not applicable

the emission density is high and thus, they become an important point source.

Solid Waste Disposal

Approximately 727,000 tons of refuse were generated during 1967 in the Study Area. This was determined by assuming a per capita disposal rate of 4.5 pounds of refuse per day.[6] Most of this refuse was disposed of by means of dumps or on-site incineration (See Table 13).

There are no sanitary landfills in the Dayton Study Area. At the various dumps in the region, the amount of burning varied from 50 to 100 percent. Twenty-five percent of the total refuse generated was assumed to be non-combustible and hence negligible in emissions.

A total of over 14,000 tons of carbon monoxide, 3,200 tons of particulate, and almost 2,000 tons of nitrogen oxides were emitted from solid waste disposal practices in the Study Area. These totals and a breakdown by jurisdiction are presented in Table 14.

Industrial Process Losses

The Dayton Study Area is for the most part void of heavy industry and thus emissions from this category did not constitute a major portion of the total. As is the case in any emission inventory, the lack of emission factors for some industrial processes did not allow for a complete estimation of process emissions.

There were six foundries in the Study Area considered in this inventory, five of which did not have any air pollution control equipment. In addition there are seven cement or concrete batching plants ranging in production from 100,000 cubic yards of cement mixed to 900,000 tons of gravel crushing and handling. There were also five asphaltic batching plants surveyed and two grain storage and handling facilities.

Emissions from industrial process losses accounted for more than 16 percent of the total particulates and only 3.5 percent of the total carbon monoxide. Locations of all point sources are shown in Figure 3.

TABLE 13 SOLID WASTE DISPOSAL BY JURISDICTION
IN THE DAYTON STUDY AREA, 1967. (TONS/YR)

County	Population	Refuse Generated[a]	Municipal Incineration	Dumps		On-Site[b]
				Total	Amount burned	
Darke	48,210	40,000	0	30,000	25,000	10,000
Greene	118,670	98,000	10,000	68,000	60,000	20,000
Miami	81,300	66,000	30,000	30,000	20,000	6,000
Montgomery	600,140	493,000	60,000	300,000	150,000	133,000
Preble	36,020	30,000	0	22,000	18,000	8,000
Total	884,340	727,000	100,000	450,000	273,000	177,000

a. Refuse generated at the rate of 4.5 lb/person-day

b. Consisted mainly of backyard burning

TABLE 14 AIR POLLUTANT EMISSIONS FROM SOLID WASTE DISPOSAL BY JURISDICTION IN THE STUDY AREA, 1967 (TONS/YEAR)

County	Source	SO_x	PART	CO	HC	NO_x
Darke	mun. inc.[a]	0[b]	0	0	0	0
	dumps	neg	150	800	50	100
	on-site	neg	60	320	20	40
	Total	neg	210	1,120	70	140
Greene	mun. inc.	10	25	5	neg	10
	dumps	neg	360	1,910	110	250
	on-site	neg	120	640	40	80
	Total	10	505	2,555	150	340
Miami	mun. inc.	25	80	10	5	25
	dumps	neg	120	640	40	80
	on-site	neg	40	190	10	20
	Total	neg	240	840	55	125
Montgomery	mun. inc.	45	390	25	5	45
	dumps	neg	900	4,800	280	620
	on-site	neg	800	4,240	250	550
	Total	45	2,090	9,065	535	1,215
Preble	mun. inc.	0	0	0	0	0
	dumps	neg	110	570	30	70
	on-site	neg	50	260	10	30
	Total	neg	160	830	40	100
Total Study Area	mun. inc.	80	495	40	10	80
	dumps	neg	1,640	8,720	510	1,120
	on-site	neg	1,070	5,650	330	720
	Total	80	3,205	14,410	850	1,920

a. mun. inc. = municipal incineration
b. neg = negligible

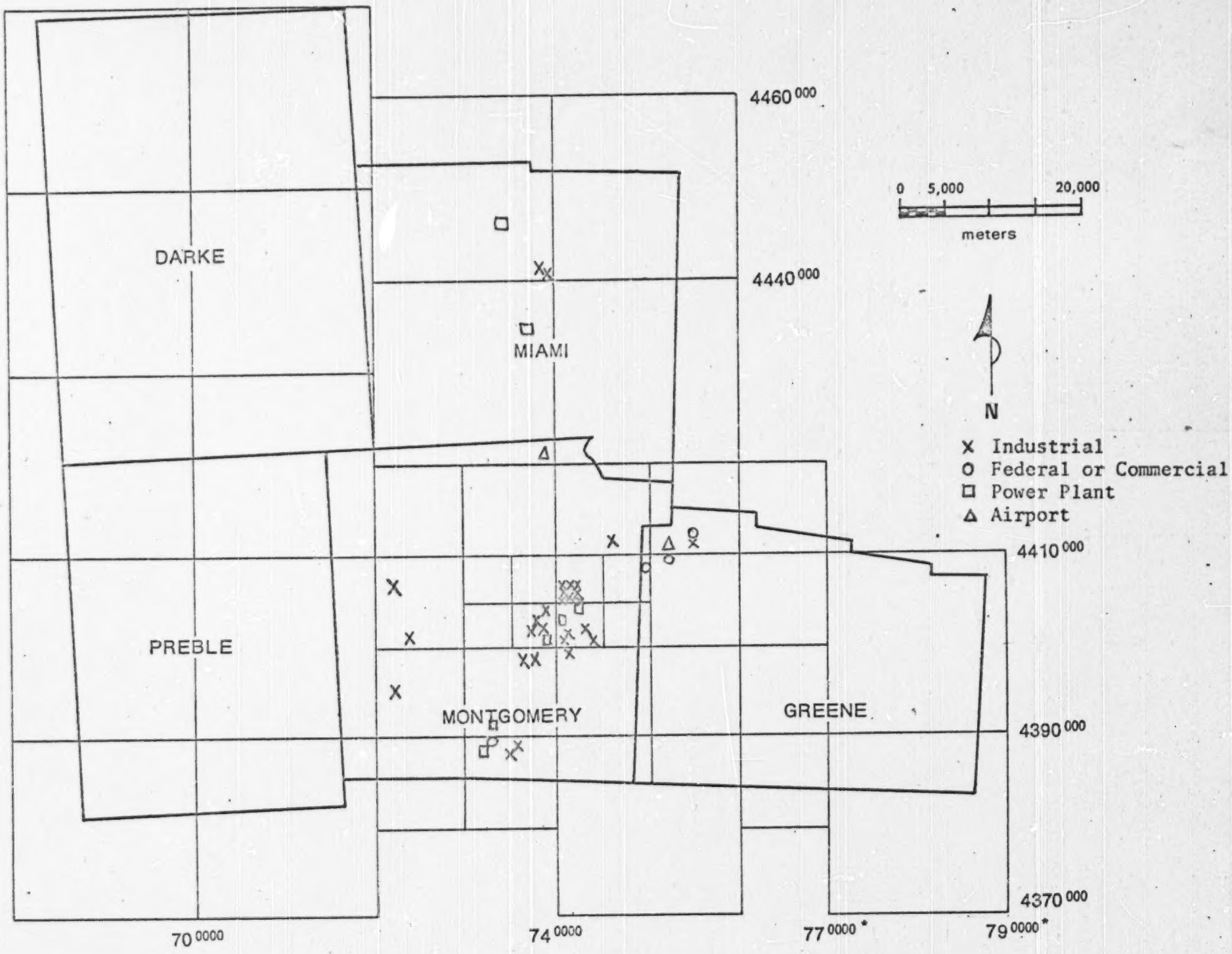

Figure 3 Location of Point Sources in the Study Area, 1967

Solvent Evaporation

Emissions from the handling and use of solvents were obtained for many of the industries in the Dayton Study Area. Most of the industries surveyed did not have any control equipment. An estimate of 15,000 tons of hydrocarbons per year was found for the area, most of which was in Montgomery county. This total does not include losses from dry cleaning plants which were not included in this survey.

Emissions by Grid

For the purposes of modeling the air pollutant emissions in the Study Area the resulting emissions were apportioned on the grid coordinate system shown in Figure 2.

An immediate need for the apportionment by grid is for the purpose of designating Air Quality Control Regions.

The emissions of each pollutant were divided into two source subgroups - point and the total of point and area sources. The point sources were identified by source category and horizontal and vertical coordinates. They are presented in Table 15 along with emissions for the five pollutants for an average annual, winter and summer day. The appendix presents the method for calculating these three averages since it differs from the Rapid Survey Technique.

The emissions for the summation of the point and area sources by grid and season are presented in Table 16. The calculation of the area source portion of these numbers is similar to that presented in the appendix for point sources.

Emission Densities by Grid

Emission densities on a grid basis were obtained by dividing the total annual emission for each grid by its appropriate area. This gives the emission density in tons per square mile per day. Figures 5 through 9 present the emission density maps for the five surveyed pollutants. Figure 4 shows the population density for the Study Area.

TABLE 15 SUMMARY OF POINT SOURCE EMISSIONS IN THE STUDY AREA, 1967 (TONS/DAY)

SOURCE CATEGORY	HC	VC	SO_x			PART			CO			HC			NO_x		
			S	W	A	S	W	A	S	W	A	S	W	A	S	W	A
Federal Facility	7523	44093	0.83	6.53	3.30	0.96	7.63	3.86	0.64	5.05	2.56	0.13	1.01	0.51	0.10	0.81	0.41
Federal Facility	7540	44125	0.83	6.53	3.30	0.96	7.63	3.86	0.64	5.05	2.56	0.13	1.01	0.51	0.10	0.81	0.41
Federal Facility	7329	43899	0.32	1.76	1.08	0.03	0.15	0.10	-	-	-	-	-	-	0.09	0.47	0.29
Industry	7362	43890	0.30	1.81	1.19	0.33	0.45	0.40	-	-	-	-	-	-	0.08	0.48	0.32
Industry	7374	43987	1.95	3.45	2.60	2.01	3.55	2.68	0.15	0.27	0.21	0.05	0.09	0.07	1.08	1.91	1.44
Industry	7383	43984	2.03	2.99	2.54	1.02	1.51	1.28	0.16	0.24	0.20	0.05	0.08	0.07	1.07	1.57	1.34
Industry	7350	43880	-	-	-	-	-	-	-	-	-	1.11	1.11	1.11	-	-	-
Industry	7407	43990	0.50	0.82	0.67	0.83	1.36	1.11	0.04	0.07	0.05	0.01	0.02	0.02	0.33	0.53	0.44
Industry	7385	44025	-	-	-	0.40	0.40	0.40	-	-	-	-	-	-	-	-	-
Industry	7390	44023	0.59	1.60	1.18	0.96	1.56	1.32	0.05	0.13	0.09	1.49	1.51	1.50	0.35	0.95	0.70
Industry	7413	44054	2.88	4.52	3.84	0.16	0.25	0.21	0.18	0.27	0.23	20.66	20.69	20.68	1.25	1.96	1.67
Industry	7385	44033	0.03	0.05	0.04	0.50	0.50	0.50	-	-	-	1.34	1.34	1.34	0.01	0.01	0.01
Industry	7390	44043	1.48	2.32	1.97	0.50	0.79	0.67	0.04	0.07	0.06	0.01	0.02	0.02	0.32	0.50	0.43
Industry	7445	44008	0.00	1.45	0.63	0.00	1.06	0.46	0.00	0.10	0.05	0.00	0.03	0.02	0.00	0.64	0.30

TABLE 15 SUMMARY OF POINT SOURCE EMISSIONS IN THE STUDY AREA, 1967 (TONS/DAY)

SOURCE CATEGORY	HC	VC	SO_x			PART			CO			HC			NO_x		
			S	W	A	S	W	A	S	W	A	S	W	A	S	W	A
Steam-electric	7324	43878	49.32	49.32	49.32	42.80	42.80	42.80	0.55	0.55	0.55	0.22	0.22	0.22	21.63	21.63	21.6
Steam-electric	7329	43914	1.56	1.56	1.56	3.56	3.56	3.56	0.07	0.07	0.07	-	-	-	0.55	0.55	0.55
Steam-electric	7390	44010	98.65	98.65	98.65	17.00	17.00	17.00	0.68	0.68	0.68	0.27	0.27	0.27	27.50	27.50	27.50
Steam-electric	7417	44048	2.26	2.26	2.26	0.39	0.39	0.39	0.03	0.03	0.03	0.01	0.01	0.01	1.23	1.23	1.23
Steam-electric	7402	44040	5.12	5.12	5.12	4.90	4.90	4.90	0.07	0.07	0.07	0.02	0.02	0.02	2.52	2.52	2.52
Steam-electric	7380	44350	3.72	3.72	3.72	9.45	9.45	9.45	0.04	0.04	0.04	0.02	0.02	0.02	1.51	1.51	1.51
Steam-electric	7360	44463	7.44	7.44	7.44	14.17	14.17	14.17	0.07	0.07	0.07	0.02	0.02	0.02	3.01	3.01	3.01
Incinerator	7280	44110	0.12	0.12	0.12	1.05	1.05	1.05	0.06	0.06	0.06	0.02	0.02	0.02	0.12	0.12	0.12
Airport	7530	44130	-	-	-	0.42	0.42	0.42	2.90	2.90	2.90	0.60	0.60	0.60	0.41	0.41	0.41
Airport	7390	44206	-	-	-	1.23	1.23	1.23	12.80	12.80	12.80	2.52	2.52	2.52	1.31	1.31	1.31
Industry	7415	44062	1.57	10.00	6.30	6.43	2.80	1.80	0.04	0.24	0.20	2.51	2.58	2.55	0.25	1.60	1.00
Federal Facility	7490	44080	0.83	6.53	3.30	0.96	7.63	3.86	0.64	5.05	2.56	0.13	1.01	0.51	0.10	0.81	0.41

TABLE 15 SUMMARY OF POINT SOURCE EMISSIONS IN THE STUDY AREA, 1967 (TONS/DAY)

SOURCE CATEGORY	HC	VC	SO_x			PART			CO			HC			NO_x		
			S	W	A	S	W	A	S	W	A	S	W	A	S	W	A
Industry	7412	44022	7.39	19.97	14.78	4.09	11.07	8.19	0.23	0.63	0.47	2.68	2.81	2.76	1.56	4.20	3.11
Industry	7437	44044	0.26	0.41	0.35	0.17	0.27	0.23	0.02	0.03	0.03	0.01	0.01	0.01	0.14	0.22	0.19
Commercial	7402	44033	0.14	1.15	0.58	1.26	9.94	5.03	0.07	0.55	0.28	0.02	0.14	0.07	0.18	1.45	0.73
Industry	7417	44060	-	-	-	0.51	0.52	0.51	-	-	-	-	-	-	0.01	0.03	0.02
Industry	7417	44060	-	-	-	33.00	33.00	33.00	-	-	-	-	-	-	-	-	-
Industry	7417	44050	-	-	-	1.50	1.50	1.50	29.10	29.10	29.10	-	-	-	-	-	-
Industry	7407	44050	6.58	10.17	8.77	6.13	9.48	8.17	0.52	0.80	0.69	3.17	3.27	3.23	4.10	6.34	5.47
Industry	7407	44050	-	-	-	-	-	-	-	-	-	3.30	3.30	3.30	-	-	-
Industry	7414	44063	0.15	0.23	0.20	0.25	0.40	0.34	0.01	0.02	0.02	0.01	0.01	0.01	0.08	0.13	0.11
Industry	7454	44117	14.25	23.24	19.00	2.55	3.81	3.22	0.38	0.61	0.50	0.12	0.20	0.17	2.50	4.08	3.33
Industry	7554	44130	14.25	23.24	19.00	4.55	7.07	5.88	0.38	0.61	0.50	0.12	0.20	0.17	2.50	4.08	3.33
Industry	7390	44410	-	-	-	-	-	-	-	-	-	2.40	2.40	2.40	-	-	-
Industry	7398	44040	1.03	1.68	1.37	0.68	1.10	0.90	0.08	0.13	0.11	0.03	0.04	0.04	0.54	0.88	0.72
Industry	7221	43950	-	-	-	0.04	0.04	0.04	3.60	3.60	3.60	-	-	-	-	-	-
Industry	7232	44020	-	-	-	0.13	0.13	0.13	0.85	0.85	0.85	-	-	-	-	-	-
Industry	7223	44070	-	-	-	2.50	2.50	2.50	-	-	-	-	-	-	-	-	-

DAYTON

TABLE 16 SUMMARY OF TOTAL AIR POLLUTANT EMISSIONS BY SEASON FOR THE STUDY AREA, 1967 (TON/DAY

Grid	Horizontal Coordinate (100m)	Vertical Coordinate (100m)	Area (Km^2)	SO_x			PART			CO			HC			NO_x		
				S	W	A	S	W	A	S	W	A	S	W	A	S	W	A
1	6900	43800	400	0.32	0.49	0.40	0.73	0.88	0.79	2.13	2.01	2.15	0.29	0.31	0.31	0.24	0.27	0.25
2	7100	43800	400	0.33	0.68	0.48	0.77	1.06	0.90	3.90	3.90	3.95	0.52	0.55	0.53	0.36	0.42	0.40
3	7250	43850	100	0.13	0.28	0.20	0.27	0.40	0.33	3.23	3.08	3.21	0.42	0.41	0.42	0.28	0.36	0.31
4	7350	43850	100	50.26	53.36	51.98	43.73	44.07	43.92	17.90	16.50	17.59	2.58	2.40	2.53	24.06	24.97	24.44
5	7500	43800	400	0.17	0.39	0.27	0.41	0.60	0.60	3.45	3.37	3.46	0.43	0.44	0.44	0.32	0.46	0.39
6	7650	43850	100	0.16	0.35	0.25	0.31	0.44	0.37	0.52	0.63	0.57	0.06	0.10	0.08	0.11	0.17	0.13
7	7800	43800	400	0.16	0.21	0.18	0.31	0.36	0.33	0.51	0.52	0.51	0.06	0.07	0.06	0.11	0.16	0.13
8	6900	44000	400	0.66	0.96	0.79	1.47	1.74	1.59	6.29	6.04	6.26	0.86	0.85	0.86	0.63	0.71	0.67
9	7100	44000	400	0.72	1.60	1.11	1.72	2.49	2.05	16.87	16.26	16.80	2.23	2.23	2.26	1.34	1.63	1.49
10	7250	43950	100	0.24	0.50	0.35	0.49	0.70	0.57	1.82	1.93	1.89	0.21	0.25	0.23	0.26	0.42	0.33
11	7350	43950	100	6.26	9.48	7.76	8.08	10.74	9.29	47.76	44.25	46.83	7.55	7.18	7.48	5.92	7.52	6.70
12	7450	43950	100	1.42	2.06	1.75	3.03	3.81	3.39	89.00	80.81	86.55	12.45	11.37	12.13	6.23	6.88	6.60
13	7550	43950	100	0.37	0.46	0.46	0.72	0.81	0.76	12.09	11.06	11.79	1.63	1.50	1.60	0.89	0.91	0.90
14	7650	43950	100	0.85	2.10	1.40	1.76	2.59	2.12	13.18	12.85	13.13	1.71	1.79	1.77	1.17	1.47	1.30
15	7250	44050	100	0.32	0.67	0.47	0.67	1.04	0.79	17.90	16.54	17.53	2.39	2.24	2.35	1.25	1.39	1.32
16	7325	44025	25	0.76	1.01	0.87	1.33	1.55	1.42	31.59	28.88	30.81	4.28	3.93	4.19	2.70	1.82	1.74
17	7375	44025	25	104.48	108.84	106.93	23.47	25.48	24.57	51.38	47.92	50.57	30.81	30.46	30.77	35.45	37.48	36.61
18	7425	44025	25	16.09	32.45	25.15	12.95	29.98	22.44	69.04	65.60	68.43	11.63	11.17	11.65	11.57	16.96	14.38
19	7475	44025	25	0.82	1.19	0.98	1.53	1.92	1.70	43.39	39.79	42.37	6.02	5.56	5.89	3.46	3.56	3.54

DAYTON

TABLE 16 SUMMARY OF TOTAL AIR POLLUTANT EMISSIONS BY SEASON FOR THE STUDY AREA, 1967 (TON/DAY)

Grid	Horizontal Coordinate (100m)	Vertical Coordinate (100m)	Area (Km^2)	SO_x			PART			CO			HC			NO_x		
				S	W	A	S	W	A	S	W	A	S	W	A	S	W	A
20	7325	44075	25	0.79	1.12	0.94	1.42	1.72	1.56	37.48	34.30	36.58	5.26	4.91	5.15	3.08	3.13	3.13
21	7375	44075	25	0.86	1.81	1.28	1.90	2.94	2.36	50.77	47.35	49.90	7.19	6.81	7.11	4.05	4.65	4.35
22	7425	44075	25	9.13	21.70	16.32	44.90	55.40	52.43	77.67	73.35	76.05	16.12	15.83	16.09	8.73	12.58	11.03
23	7475	44075	25	0.81	1.04	0.91	1.41	1.59	1.51	40.57	37.00	39.54	5.89	5.43	5.76	3.25	3.22	3.27
24	7550	44050	100	1.08	1.17	1.12	2.01	2.08	2.04	29.62	26.91	28.82	4.05	3.68	3.94	2.69	2.60	2.67
25	7650	44050	100	0.34	0.39	0.36	0.64	0.69	0.64	6.04	5.53	5.89	0.82	0.75	0.84	0.49	0.51	0.50
26	7800	44000	400	0.51	0.65	0.57	1.00	1.13	1.05	9.31	8.60	9.12	1.25	1.16	1.22	0.78	0.87	0.83
27	6900	44200	400	0.57	0.87	0.81	1.23	1.52	1.36	7.82	7.44	7.76	1.06	1.04	1.07	0.68	0.76	0.73
28	7100	44200	400	0.60	1.12	0.82	1.36	1.82	1.56	15.80	14.90	15.60	2.13	2.05	2.12	1.20	1.34	1.27
29	7250	44150	100	0.32	0.69	0.48	0.66	0.95	0.79	17.95	16.62	17.59	2.39	2.25	2.36	1.25	1.40	1.33
30	7350	44150	100	0.63	1.23	0.89	1.28	1.79	1.51	51.35	47.11	51.16	6.91	6.38	6.77	3.38	3.54	3.50
31	7450	44150	100	0.87	1.60	1.19	1.72	2.35	2.00	51.77	47.65	50.63	6.95	6.45	6.82	3.52	3.78	3.68
32	7550	44150	100	30.09	47.50	38.80	9.97	14.17	12.06	28.53	27.20	28.30	4.13	4.09	4.19	7.23	10.70	9.04
33	7650	44150	100	0.50	0.59	0.54	0.97	1.06	1.01	6.45	5.68	6.12	0.84	0.79	0.83	0.59	0.54	0.59
34	6900	44400	400	1.06	1.83	1.40	2.74	3.45	3.05	20.24	19.22	20.05	2.73	2.64	2.73	1.69	1.99	1.85
35	7100	44400	400	0.24	0.61	0.40	0.57	0.92	0.73	9.47	9.02	9.39	1.27	1.24	1.27	0.73	0.84	0.79
36	7300	44300	400	6.76	7.48	7.07	17.11	17.78	17.40	47.12	44.79	46.52	7.17	6.92	7.02	5.26	5.56	5.41
37	7500	44300	400	1.31	1.51	1.34	2.57	2.84	2.70	13.95	12.99	13.68	1.89	1.78	1.86	0.99	1.11	1.06
38	6900	44600	400	0.21	0.68	0.42	0.51	0.91	0.69	6.32	6.21	6.35	0.86	0.88	0.89	0.46	0.55	0.50

DAYTON

TABLE 16 SUMMARY OF TOTAL AIR POLLUTANT EMISSIONS BY SEASON FOR THE STUDY AREA, 1967 (TONS/DAY)

Grid	Horizontal Coordinate (100m)	Vertical Coordinate (100m)	Area (Km^2)	SO_x			PART			CO			HC			NO_x	
				S	W	A	S	W	A	S	W	A	S	W	A	S	W	A
39	7100	44600	400	0.23	0.96	0.55	0.57	1.18	0.84	9.46	9.32	9.61	1.27	1.31	1.30	0.66	0.80	0.73
40	7300	44500	400	10.48	11.17	10.78	23.09	23.73	23.37	35.19	32.73	34.56	7.32	7.04	7.37	5.50	5.77	5.74
41	7500	44500	400	1.66	2.84	2.23	1.97	2.84	2.38	8.12	7.97	8.16	1.11	1.15	1.15	1.09	1.52	1.32

Figure 5 presents the emission density for sulfur oxides. As can be seen the densities are high in some of the regions where population densities are low. This is primarily due to the fact that steam-electric power plants which are the major source of sulfur oxides are located here.

In Figure 6, the particulate emission density has been delineated. This, too, is high in the outer areas because of the effect of power plants.

The carbon monoxide densities are shown in Figure 7. This shows that the emissions are highest in the downtown areas of Dayton as would be expected. However, as one moves out of the city, the densities are higher in a north-south direction rather than in an east-west. This is due to the predominance of heavily travelled roads in this direction such as the interstate freeway I-75.

Because motor vehicles account for a large percentage of the total hydrocarbons, the same effect is observed for hydrocarbon densities as was found for carbon monoxide, i.e. high in the city, radiating in a north-south rather than an east-west direction.

Since power plants account for almost 35 percent of the nitrogen oxides, the high density locations are similar to those of sulfur oxides and particulates as can be seen from Figure 9.

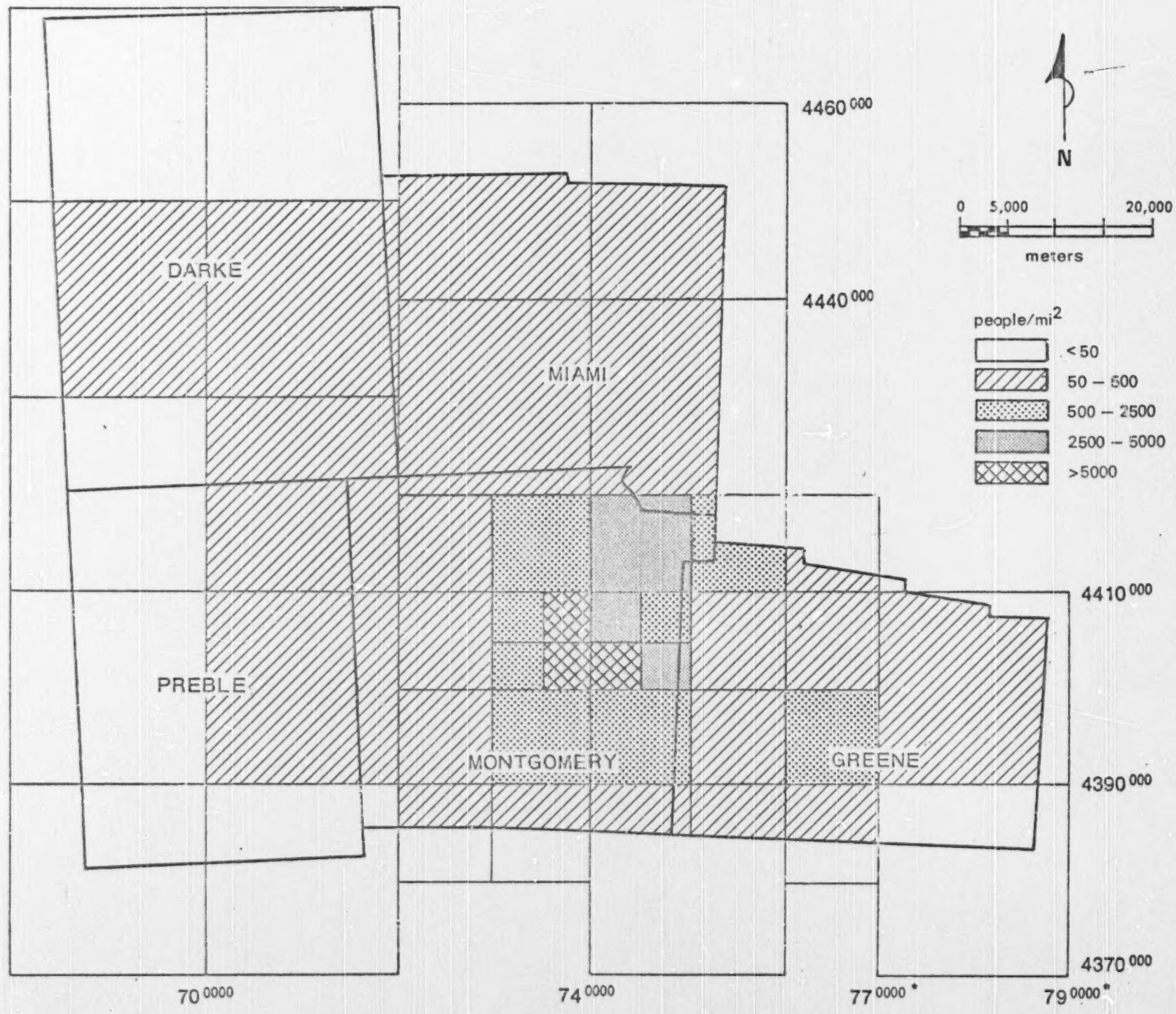

Figure 4. Population density for the study area, 1967.

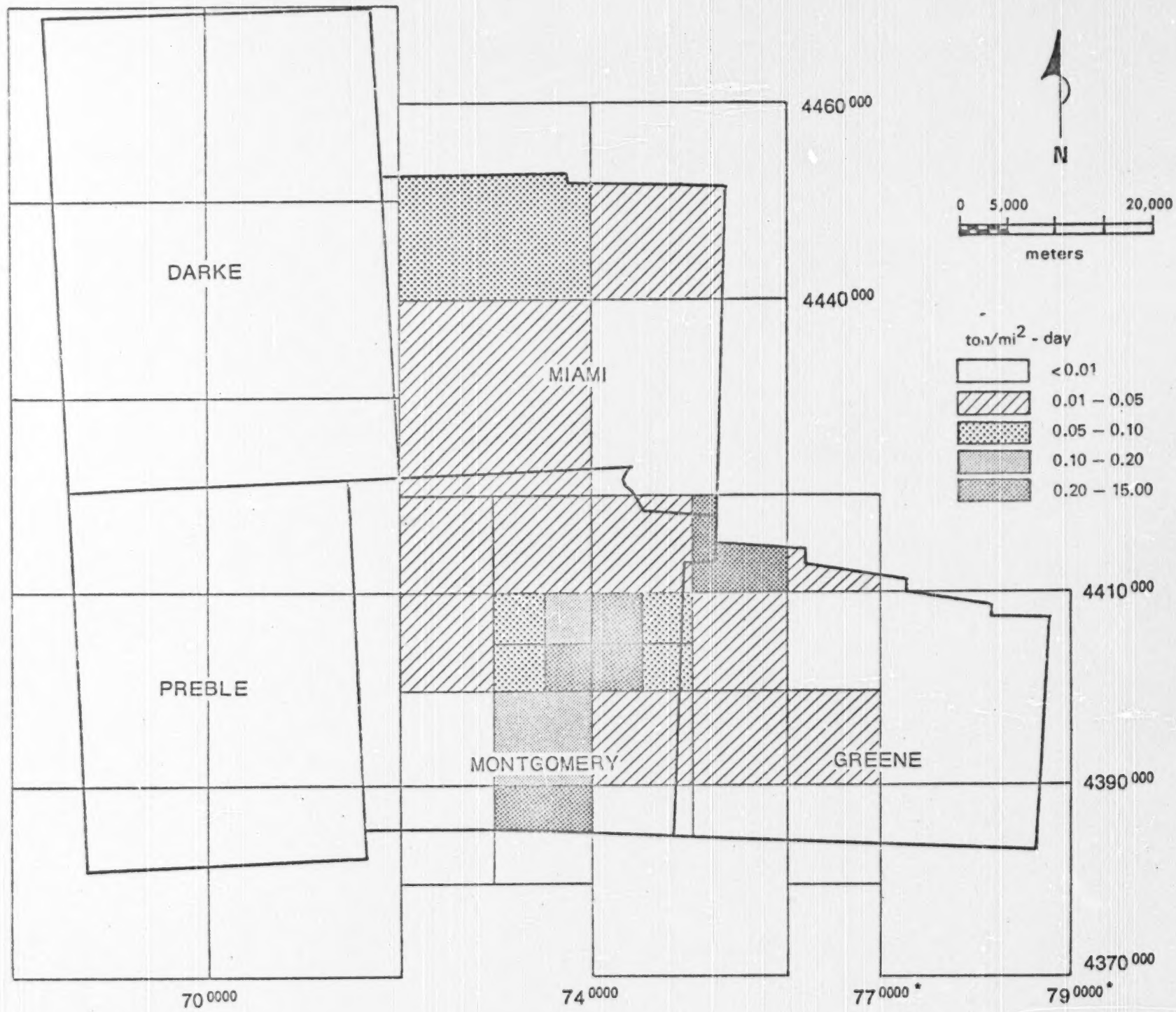

Figure 5. Sulfur oxide emission density from all sources.

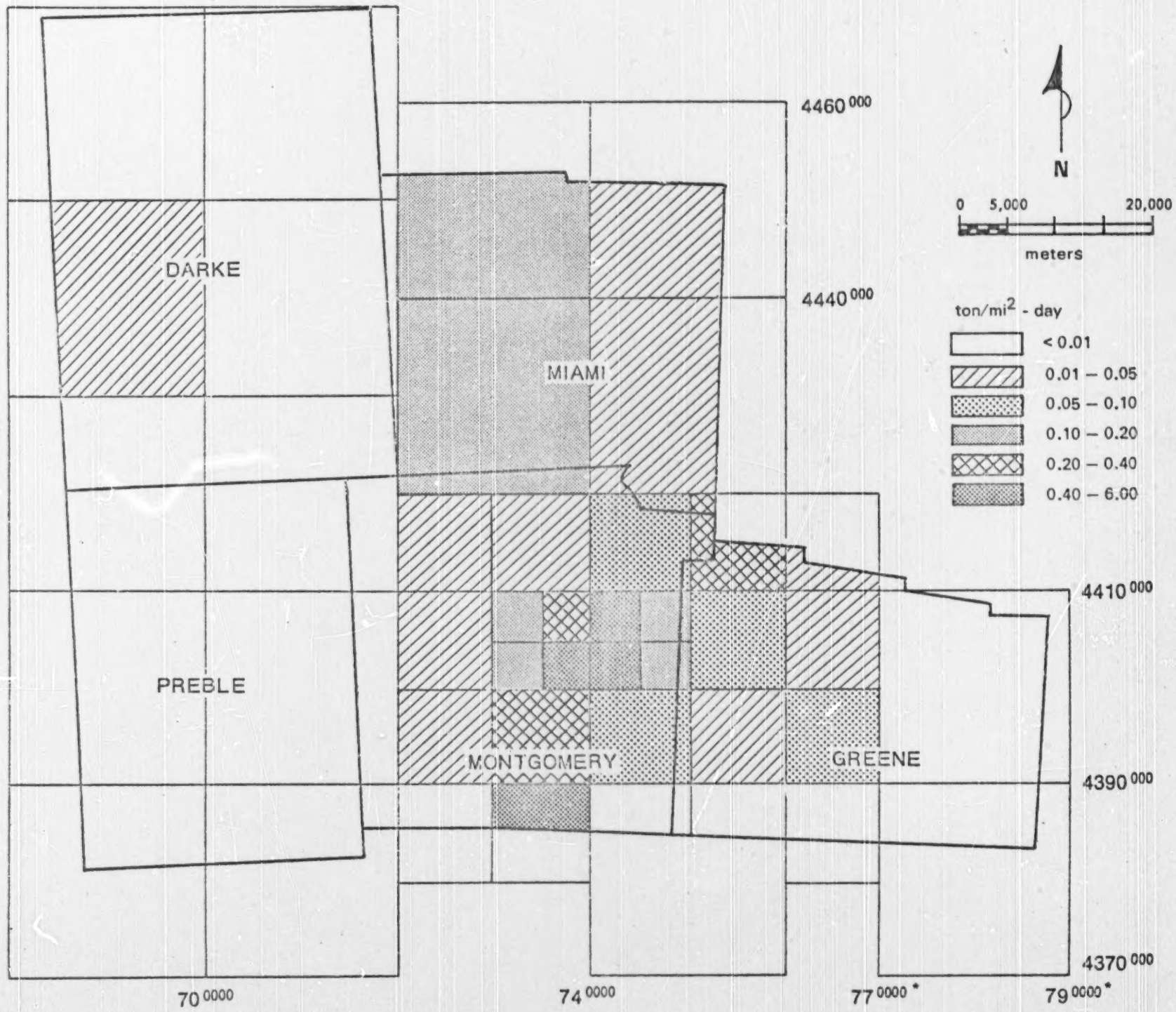

Figure 6. Particulate emission density from all sources.

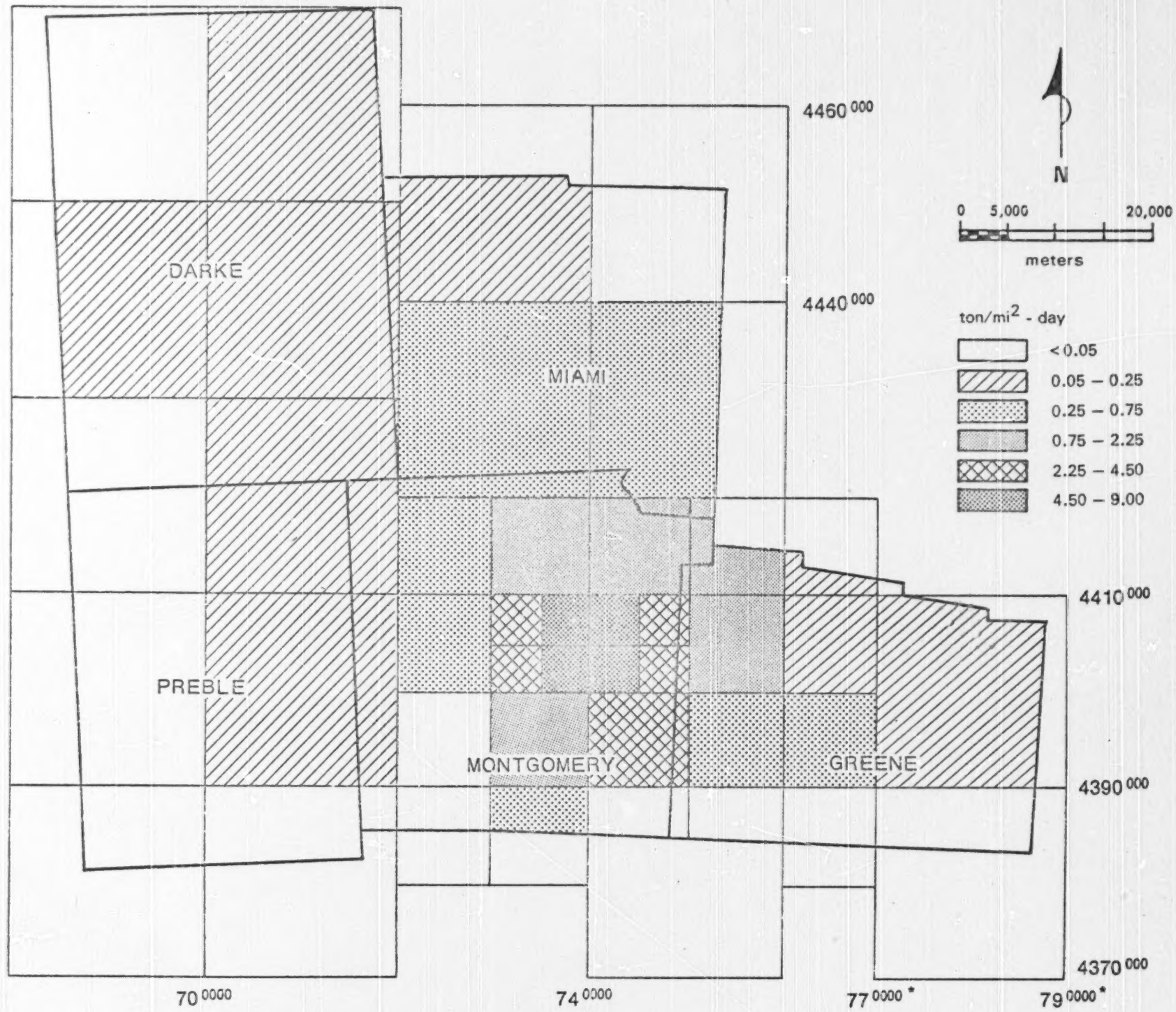

Figure 7. Carbon monoxide emission density from all sources.

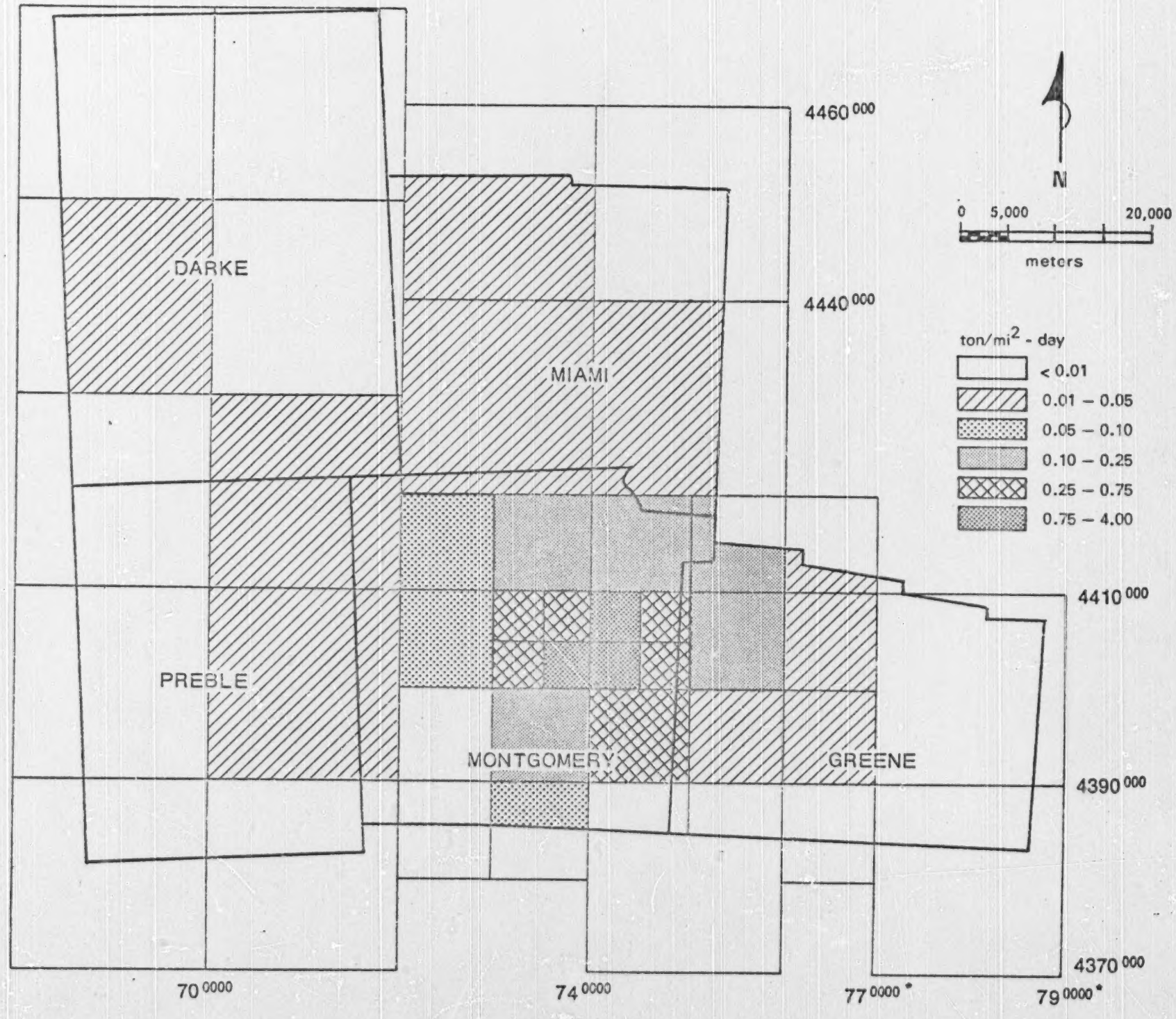

Figure 8. Hydrocarbon emission density from all sources surveyed.

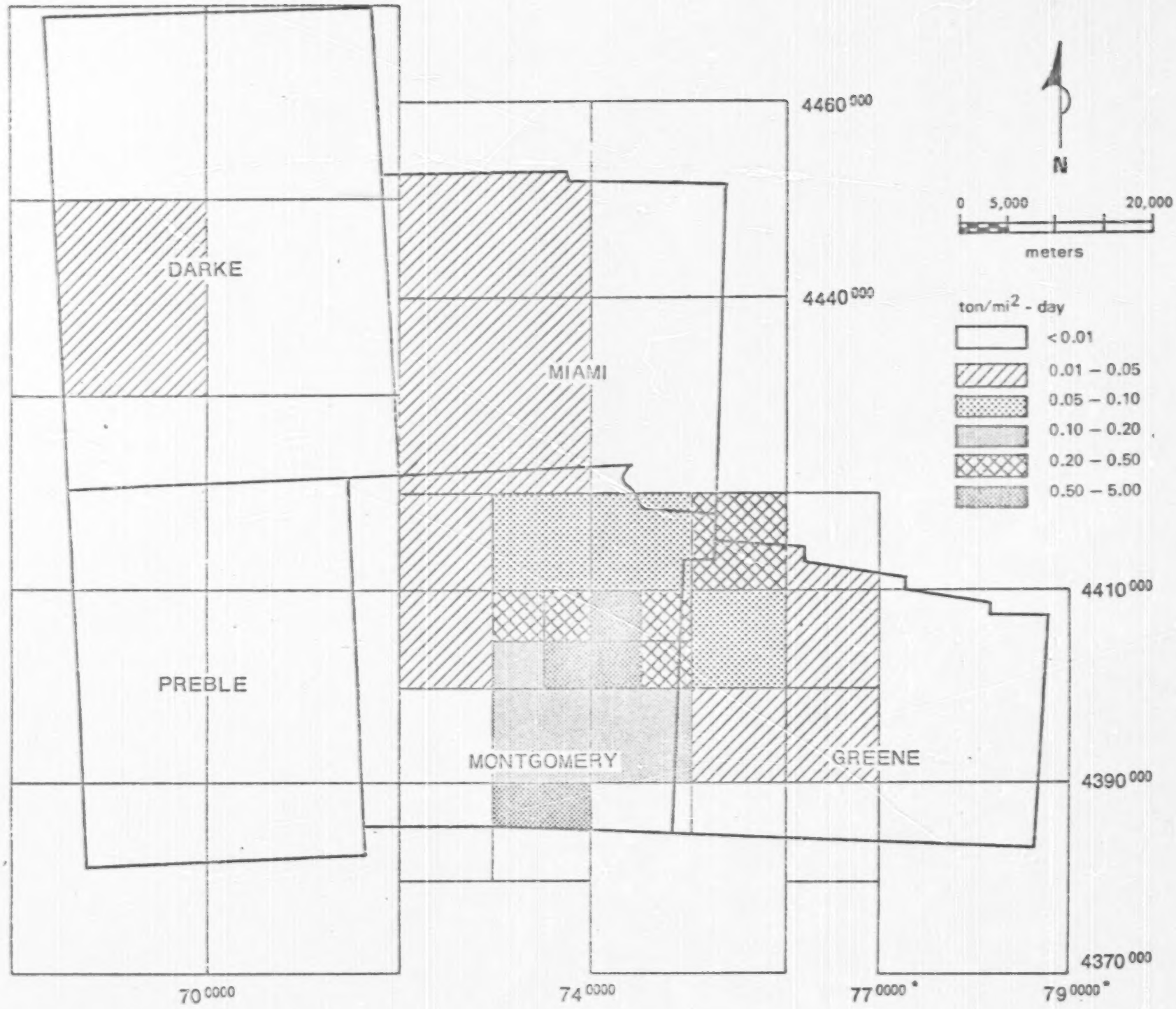

Figure 9. Nitrogen oxide emission density from all sources.

AREA SOURCE EMISSIONS BY SEASON FOR THE DAYTON STUDY AREA, 1967 (TONS/DAY)

Grid	HC	VC	Area (Km^2)	SO_x			PART			CO		
				S	W	A	S	W	A	S	W	A
1	6900	43800	400	0.32	0.49	0.40	0.73	0.88	0.79	2.13	2.01	2.15
2	7100	43800	400	0.33	0.68	0.48	0.77	1.06	0.90	3.90	3.90	3.95
3	7250	43850	100	0.13	0.28	0.20	0.27	0.40	0.33	3.23	3.08	3.21
4	7350	43850	100	0.32	0.47	0.39	0.57	0.67	0.62	17.45	15.93	17.02
5	7500	43800	400	0.17	0.39	0.27	0.41	0.60	0.60	3.45	3.37	3.46
6	7650	43850	100	0.16	0.35	0.25	0.31	0.44	0.37	0.52	0.63	0.57
7	7800	43800	400	0.16	0.21	0.18	0.31	0.36	0.33	0.51	0.52	0.51
8	6900	44000	400	0.66	0.96	0.79	1.47	1.74	1.59	6.29	6.04	6.26
9	7100	44000	400	0.72	1.60	1.11	1.72	2.49	2.05	16.87	16.26	16.80
10	7250	43950	100	0.24	0.50	0.35	0.49	0.70	0.57	1.82	1.93	1.89
11	7350	43950	100	2.28	3.04	2.62	5.05	5.68	5.33	47.45	43.74	46.42
12	7450	43950	100	0.92	1.24	1.08	2.20	2.45	2.28	88.98	80.74	86.50
13	7550	43950	100	0.37	0.46	0.46	0.72	0.81	0.76	12.09	11.06	11.79
14	7650	43950	100	0.85	2.10	1.40	1.76	2.59	2.12	13.18	12.85	13.13
15	7250	44050	100	0.32	0.67	0.47	0.67	1.04	0.79	17.90	16.54	17.53
16	7325	44025	25	0.76	1.01	0.87	1.33	1.55	1.42	31.59	28.88	30.81
17	7375	44025	25	0.85	1.70	1.23	1.83	2.75	2.24	50.43	46.87	49.51
18	7425	44025	25	0.92	2.09	1.43	2.14	3.41	2.70	64.62	60.19	63.50
19	7475	44025	25	0.82	1.19	0.98	1.53	1.92	1.70	43.39	39.79	42.37

AREA SOURCE EMISSIONS BY SEASON FOR THE DAYTON STUDY AREA, 1967 (TONS/DAY)

Grid	HC	VC	Area (Km^2)	SO_x S	SO_x W	SO_x A	PART S	PART W	PART A	CO S	CO W	CO A
20	7325	44075	25	0.79	1.12	0.94	1.42	1.72	1.56	37.48	34.30	36.58
21	7375	44075	25	0.86	1.81	1.28	1.90	2.94	2.36	50.77	47.35	49.90
22	7425	44075	25	0.83	1.30	1.05	1.60	2.11	1.92	48.00	43.19	45.94
23	7475	44075	25	0.81	1.04	0.91	1.41	1.59	1.51	40.57	37.00	39.54
24	7550	44050	100	1.08	1.17	1.12	2.01	2.08	2.04	29.62	26.91	28.82
25	7650	44050	100	0.34	0.39	0.36	0.64	0.69	0.64	6.04	5.53	5.89
26	7800	44000	100	0.51	0.65	0.57	1.00	1.13	1.05	9.31	8.60	9.12
27	6900	44200	400	0.57	0.87	0.71	1.23	1.52	1.36	7.82	7.44	7.76
28	7100	44200	400	0.60	1.12	0.82	1.36	1.82	1.56	15.79	14.89	15.59
29	7250	44150	100	0.32	0.69	0.48	0.66	0.95	0.79	17.95	16.62	17.59
30	7350	44150	100	0.63	1.23	0.89	1.28	1.79	1.51	51.35	47.11	51.16
31	7450	44150	100	0.87	1.60	1.19	1.72	2.35	2.00	51.77	47.65	50.63
32	7550	44150	100	0.59	1.04	0.79	1.35	1.77	1.54	24.87	23.09	24.40
33	7650	44150	100	0.50	0.59	0.54	0.97	1.06	1.01	6.45	5.68	6.12
34	6900	44400	400	1.04	1.78	1.36	2.34	3.05	2.65	20.24	19.22	20.05
35	7100	44400	400	0.24	0.61	0.40	0.57	0.92	0.73	9.47	9.02	9.39
36	7300	44300	400	3.04	3.76	3.35	6.43	7.10	6.72	34.28	31.95	33.68
37	7500	44300	400	1.31	1.51	1.34	2.57	2.84	2.70	13.95	12.99	13.68
38	6900	44600	400	0.21	0.68	0.42	0.51	0.91	0.69	6.32	6.21	6.35

AREA SOURCE EMISSIONS BY SEASON FOR THE DAYTON STUDY AREA, 1967 (TONS/DAY)

Grid	HC	VC	Area (Km^2)	SO_x			PART			CO		
				S	W	A	S	W	A	S	W	A
39	7100	44600	400	0.23	0.96	0.55	0.57	1.18	0.84	9.46	9.32	9.61
40	7300	44500	400	3.04	3.73	3.34	6.42	7.06	6.70	35.12	32.66	34.49
41	7500	44500	400	0.63	1.16	0.86	1.29	1.74	1.48	8.04	7.84	8.05

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